

**SECTION 16730
FIRE ALARM SPECIFICATION, LOCAL BUILDING DEVICES**

PART 1 - GENERAL

1.1 REFERENCES

- A. The Publications listed below form a part of this specification to the extent referenced. Where publication or edition dates are not provided, the most current edition shall be used. The publications are referred to in the text by basic designation only.
1. DOE ORDERS
 - a. DOE Environmental, Safety and Health Protection Standards
 - b. DOE 420.1 Facility Safety
 - c. DOE 420.2 Safety of Accelerator Facilities
 2. NFPA
 - a. NFPA 13 Installation of Sprinkler Systems (1996)
 - b. NFPA 70 National Electric Code (1996)
 - c. NFPA 72 National Fire Alarm Code (1996)
 - d. NFPA 75 Electronic Computer/Data Processing Equipment (1995)
 - e. NFPA 90A Installation of Air Conditioning Systems (1999)
 - f. NFPA 92A Smoke Control Systems (1996)
 - g. NFPA 101 Life Safety Code (1997)
 - h. NFPA 110 Emergency Power Systems (1996)
 - i. NFPA 318 Standard for the Protection of Cleanrooms (2000)
 3. OAK RIDGE NATIONAL LABORATORY DESIGN DOCUMENTS
 - a. ORNL Design Criteria – Fire Protection-Deviations – NFPA 13 and NFPA 101
 - b. ORNL Technical Specification Section 15104A Fire Protection 4-24-96
 - c. ORNL Technical Specification Section 16721 Fire Alarm Systems 4-2-97
 4. DEPARTMENT OF LABOR
 - a. OSHA Section 29 CFR 1910.36(b)(7)
 - b. OSHA Section 29 CFR 1910.164
 5. OTHER
 - a. ADA Accessibility Guidelines for Buildings and Facilities, January, 1998
 - b. UL Fire Protection Equipment Directory
 - c. Factory Mutual Approval Guide-Fire Protection Equipment

1.2 GENERAL REQUIREMENTS

- A. Purpose: This Section describes the Building Fire Alarm Systems, the devices and systems used to initiate and indicate fire alarms, monitor fire suppression systems, control auxiliary Life Safety functions and the installation, testing and acceptance of these devices. This Section also describes the performance of circuits used to connect devices to the local fire detection and alarm control panels that will connect each building to the Site Fire Alarm System. Specification of the local fire detection and alarm control panels and system operation is included in Section 16735 – Site Fire Detection and Alarm System. Required device types and operational parameters are indicated in the appendices of this Section
- B. This is a "design-build" turnkey project. The Contractor shall provide the Construction Manager (CM) with a complete, fully functional system designed in accordance with the requirements presented in each Specification section.
- C. Design: The Building Fire Alarm Systems shall be provided in accordance with the requirements of this Section, as well as, NFPA 72 and other appropriate codes and standards.
- D. Terminology: Terminology used in this specification is as defined in NFPA 72.

- E. System Description: The fire detection and alarm system for the building at the CNMS Facility shall be designed and installed in accordance with the requirements of this section for all buildings and for each building as further specified. The system will operate as described herein and as outlined and described in Section 16735.
- F. Service Conditions
 - 1. Items provided under this section shall be specifically suitable for the following service conditions.
 - a. Altitude: 1,000 feet
 - b. Ambient Temperature: -20 to 110 °F (exterior systems) and 32 to 120 °F & 85% humidity (interior systems, except as conditioned)
 - c. Seismic Parameters: Addressed in the Appendices, as necessary, for each protected structure/building.
- G. Related Sections of the Specifications
 - 1. Section 15300 – Fire Suppression Master Specification.
 - 2. Section 16735 – Site Fire Detection and Alarm System.

1.3 QUALITY ASSURANCE:

- A. Contractor Qualifications
 - 1. The Fire Detection and Alarm System Contractor shall be a factory authorized fire alarm system installer for all systems included herein.
 - 2. The Fire Detection and Alarm System Contractor shall hold all licenses and permits necessary to perform this work.
 - 3. The Fire Detection and Alarm System Contractor shall have several years of experience in the installation of systems of this type and be familiar with all applicable local, state and federal laws and regulations.
 - 4. The Fire Detection and Alarm System Contractor shall be regularly engaged in the design, servicing, installation and testing of fire detection and alarm systems.
 - 5. The Fire Detection and Alarm System Contractor shall submit a list of installations, preferably of similar scope and magnitude, which were completed within the last three (3) years, including a contact person for each reference. This list shall be submitted at the pre-bid meeting.
 - 6. The design of fire protection systems shall be done under the supervision of a Professional Engineer registered in the State of Tennessee as a Fire Protection Engineer. The design shall bear the stamp of the supervising Fire Protection Engineer.
 - 7. The Construction Manager may reject any proposed contractor who cannot show evidence of proper qualifications.
- B. Sub-Contractors
 - 1. The Construction Manager must approve all sub-contractors in writing.
 - 2. All sub-contractors shall meet the quality assurance requirements listed for the Contractor in Section 1.3.A.

1.4 SUBMITTALS

- A. Construction Manager approval is required for all submittals. After verifying all field measurements and after complying with the applicable procedures specified in the Contract Documents, the Contractor shall submit for review and approval, with such promptness as to cause no delay in the work, all technical Submittals, as specified. The Submittals shall be in accordance with any appropriate General and Supplementary Conditions.
- B. Data

1. Battery Load Calculations: Submit calculations for fire detection and alarm system back-up battery loads for standby and alarm conditions. Calculations shall indicate voltage drops in worst -case conditions for each circuit.
 2. Manufacturers Catalog Data: Submit data (including catalog cuts, brochures, specifications, product data and/or information regarding UL Listings or Factory Mutual approvals) in sufficient detail and scope to verify compliance with the requirements of the contract documents.
 3. Material, equipment and fixture lists: A complete itemized listing of equipment and materials proposed for incorporation into the work shall be submitted. Each entry shall include an item number, the quantity and the name of the manufacturer or supplier of each item. The listing shall include the following:
 - a. Conduit, raceway, junction boxes, terminal cabinets, device back boxes, fittings, hangers and mounting hardware.
 - b. Wire, cable, connectors, and terminal strips.
 - c. Manual fire alarm stations, detectors, water flow and valve supervisory devices, auxiliary function relays and evacuation signaling devices.
 - d. Any other materials, devices or equipment to be provided.
- C. Shop Drawings
1. Shop drawings shall be provided in the format required by the project General and Supplementary Conditions. Current AE drawings shall be provided to the Contractor and used as backgrounds for the shop drawings. Drawings shall contain no extraneous information. Marked up copies of catalog data sheets or manufacturer's "typical" diagrams are not acceptable in lieu of the required drawings or diagrams. Drawing method shall be in accordance with the CNMS CF CADD Plan and associated Appendix F. Contractor shall submit a test plan for acceptance testing for approval with shop drawings.
 2. Shop drawings shall include:
 - a. A drawing legend sheet identifying:
 - 1) All symbols used on the drawings, by type of device or equipment, manufacturer and manufacturers part number. This information shall correspond to the manufacturer's catalog data sheets required as part of the equipment list.
 - 2) All conventions, abbreviations and specialized terminology used on the drawings, as necessary to understand and interpret the information contained thereon.
 - 3) All color codes and conduit, conductor/circuit and/or device numbering systems.
 - 4) A complete drawing list/index identifying all drawings in the shop drawing package by title, drawing number and Specification cross-reference.
 - b. Plan view drawings based upon the project architectural plans and drawn to 1/8-inch scale or larger, showing:
 - 1) Name of Project.
 - 2) Location, including street address.
 - 3) Point of compass.
 - 4) Graphical scale indicator.
 - 5) Locations of all walls, partitions extending to within 18" of the ceiling, major room fixtures that may obstruct optical detectors or visible alarm appliances, ceiling obstructions, exits and anticipated fire department response points.
 - 6) Use or occupancy of each room or area (i.e., office, mechanical, storage, laboratory, etc.).
 - 7) Locations of all fire alarm system devices, equipment, risers and electrical power connections, including sufficient dimensions for the contractor to properly position the device/equipment.

- 8) Locations and identification of all non-fire alarm system equipment monitored and/or controlled by the fire alarm system. This shall include a riser diagram with the address of each device.
 - 9) Point-to-point (actual) conduit, raceway and circuit routing, identifying number, size and type of conduits/raceways and conductors. This information shall be depicted in sufficient detail to readily locate specific conduits, raceways and circuits in the field and to identify the specific conductors/circuits contained therein. All penetrations of fire-rated barriers shall be individually noted.
 - 10) Conduit fills calculations, in chart form, indicating the cross-section area percent fill for each type of wire/cable in each size of conduit used in the system.
- c. Typical wiring diagrams for all alarm initiating and alarm indicating devices, identifying all required terminations, including types of terminations (terminals or pigtails) and pigtail/terminal identifications. All unsupervised connections and terminations shall be noted "unsupervised."
 - d. Any additional information necessary for installation of the system devices and wiring to the point of connection to the local fire alarm control panel, including copies of all cross-referenced drawings and documents.

D. Material Samples

1. Material samples shall be provided concurrent with the Shop Drawing Submittal. Contractor shall provide samples in accordance with the requirements of the General and Supplementary Conditions. In addition, samples shall be submitted in original factory cartons (if applicable) with all factory documentation. Such documentation shall include evidence of UL listing or FM approval, as required. Samples of the following items shall be submitted:
 - a. Manual fire alarm stations.
 - b. Various smoke and heat Detectors.
 - c. Suppression system and supervisory devices.
 - d. Fire door hold-open devices.
 - e. Alarm indicating devices.
 - f. Addressable monitoring and control modules.
 - g. Manual control switches.
 - h. Fault isolator modules).
 - i. Wire and cable: Samples shall be 24 inches in length, minimum, and shall be labeled to identify the type of wire or cable, manufacturer, manufacturer's part number, and a description of the intended use for that particular wire or cable.

E. Record Drawings

1. Record Drawings shall be maintained in accordance with the requirements of the General and Supplementary Conditions

F. Operation and Maintenance (O & M) Manuals

1. Preliminary O & M Manuals
 - a. Preliminary O & M Manuals shall be provided, pursuant to this specification and the supplementary conditions, with the shop drawings. The manuals will be reviewed for required content and approved or disapproved on that basis. Upon completion of the project, the Contractor shall revise the approved, preliminary manual to be consistent with the system as installed and specifically to coordinate the testing and maintenance schedule with the approved Contractor testing protocols and with the device numbers indicated on the Contractor's Record Drawings.
2. Final O & M Manuals (Including Final Record Drawings)
 - a. The Final Operations and Maintenance Manual shall constitute the basis for the on-site training sessions required elsewhere in this Section and, as such, shall

be both specific to this system, containing a minimum of superfluous information, and suitable for that purpose. This manual shall be written, compiled and edited specifically for this project and the system installed. The Final O & M manual shall include copies of Final Record Drawings. Unedited manufacturer's catalog data sheets and/or equipment manuals are unacceptable as content for this submittal.

G. Reports

1. Test Reports (procedures and checklists) for all required tests shall be submitted in accordance with appropriate requirements of the General and Supplementary Conditions. A test plan must be approved prior to commencing any acceptance tests.
 - a. The Test Reports shall include a detailed narrative description of each test/verification performed (consistent with the approved test protocols required elsewhere in these specifications), the date and time, results and the initials of the parties performing and witnessing each test/verification.
 - b. The Test Reports shall become a part of the permanent record and contain signatures of contractor's representatives involved in each phase of testing.

1.5 CONFLICTS

- A. The referenced codes and standards represent minimum requirements for items not otherwise addressed in the Plans and Specifications. The Construction Manager reserves the right to specify requirements that exceed the requirements of either, the referenced codes and standards, typical industry practice, or both. Such differences between the bid documents and the referenced codes and standards/typical industry practice shall not be recognized as conflicts and shall not be grounds for adjustments to the contract.
- B. In the event of conflicts between these Specifications and/or the contract drawings and/or the referenced codes and standards, it is the Contractor's responsibility to notify the Construction Manager of such conflict in writing at least 7 days prior to bid. Any conflicts, which are not identified prior to bid, shall be subject to resolution, at the Construction Manager's discretion, by applying the more stringent criteria.
- C. No construction or installation will be authorized until the required submittals are received, reviewed and accepted by the Construction Manager. Any construction or installation performed without written authorization from the Construction Manager shall be entirely at the Contractor's own risk.
- D. As the specified submittals are essential to the Construction Manager's quality assurance effort and necessary to document the installation for future expansion, modification, service, testing and maintenance, overdue and/or unacceptable submittals may, at the sole discretion of the Construction Manager, result in the immediate suspension of all payments to the Contractor until such time as the problem is corrected.

1.6 SYSTEM REQUIREMENTS

A. System Architecture

1. Local fire detection and alarm system components, installed pursuant to these Specifications, shall include:
 - a. Local Fire Detection and Alarm System devices (and associated wiring) that provide detection, alarm, supervisory and control functions to local building Protected Premises Fire Alarm Systems (PPFAS).
 - b. Intelligent addressable devices providing a discrete system "address" for each input, output and control device.

- c. All required hardware, raceways and interconnecting wiring to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein.
- d. The latest state of the art products of the Edwards System Technology, EST-3 system, VESDA, and the other equipment outlined in this Specification. All equipment shall be new and in fully operable condition.
- e. The contractor or system manufacturer shall certify that spare parts for the system and components will be available and stocked for at least 10 years.

B. System Performance and Supervision

- 1. All wiring required for proper system operation, except as specifically allowed herein, shall be electrically supervised for opens, shorts between pairs and shorts to ground. Wiring faults on supervised circuits shall initiate trouble conditions.
- 2. Circuits shall conform to the requirements of NFPA 72 as follows:
 - a. Signaling Line Circuits – Class B, Style 4.
 - b. Initiating Device Circuits – Class B, Style 4.
 - c. Notification Appliance Circuits-Class B, Style Y.
- 3. All power supply circuits, including 24VDC power supply circuits shall be supervised using end-of-line power supervisory relays monitored by addressable monitor modules, one per power circuit, connected to the Fire Alarm Control Panel.
- 4. Shield drain conductors need not be supervised. These conductors shall be tested for continuity and shorts to ground, and that testing shall be documented in writing, prior to final acceptance of the completed systems.
- 5. All addressable devices shall be field programmable via a laptop computer. All programmed information shall be stored in nonvolatile memory after loading into the Protected Premises System of local Protected Premises Fire Alarm Control Panels. No special programming terminal or prom burning shall be required and the system shall continue in service during reprogramming. During program reading or loading, the system shall retain the capability for alarm reporting.
- 6. Specified devices shall operate in accordance with the Input/Output matrices included in the Appendices.
- 7. System shall be provided with battery backup for all equipment. The backup power supply shall be designed for 5 minutes of operation in alarm, following a 24-hour period of AC power interruption.

C. Component Supervision

1. All control components shall be placement supervised such that removal of any control module shall cause a trouble signal.
2. All remote power supplies shall be supervised for loss of normal AC operating power. Loss of AC power to any power supply/battery charger shall cause a supervisory signal.
3. All power supplies shall continuously monitor the presence of the batteries, battery voltage, and charging status, causing a trouble signal in response to a low battery, missing battery or charger failure condition.
4. All manual fire alarm stations, detectors, evacuation signaling devices and auxiliary function relays or other devices shall be supervised such that removal of any manual fire alarm station, detector, evacuation signaling device, auxiliary function relay or other device shall cause a trouble signal.
5. Devices and circuits shall allow automatic testing by the PPFAS via a continuous polling interrogation/response operation. Failure of one or more addressable initiating devices shall cause a trouble signal.

D. Weatherproof Equipment

1. All conduit fittings, devices, and device back boxes installed outdoors shall be weatherproof type.
2. All rigid conduit connections shall be sealed with Teflon tape.
3. All junction boxes and device back boxes used outdoors shall be gasketed.

PART 2 - MATERIALS

2.1 COMPONENTS

A. Product Listing and Approvals

1. As appropriate, all system components shall be listed by Underwriter's Laboratories, Inc. (UL) or approved by Factory Mutual (FM) if the component is from a category of devices that are listed/approved by UL or FM.
2. Components requiring approval shall be delivered to the project site with factory applied UL and/or FM stickers. System components, which do not meet these requirements, are not acceptable unless specifically approved in writing by the Construction Manager.

B. Fire Alarm Control Panel

1. Local Fire Alarm Control Panel and panel functions are specified in Section 16735 – Site Fire Detection and Alarm System.

C. Addressable Interface Modules

1. Addressable interface modules shall be provided for each non-addressable input. Such inputs may include (but are not limited to) water flow switches, valve supervisory switches and air sampling smoke detectors.
2. Addressable interface modules shall support a Class B (Style 4 or Y) initiating device circuit for shorting-type contact devices.
3. Dual Input Modules may be used in locations requiring more than one interface module in close proximity to each other. Only one input device shall be connected to each of the module addresses. For device count purposes, a dual input module is considered equal to two monitor modules.
4. Universal Input/Output Module Motherboards may be used to connect multiple interface modules in locations requiring multiple interface modules in close proximity to each other.

D. Addressable Control Modules

1. Addressable control modules shall be provided for control of auxiliary functions. Such functions may include (but is not limited to) control of fans and the release of fire-rated doors.
 2. Addressable control modules shall provide a form "C" dry relay rated at 2 amps @ 24vdc to control external devices or provide for equipment shutdown.
 3. Universal Input/Output Module Motherboards may be used to connect multiple interface modules in locations requiring multiple interface modules in close proximity to each other.
- E. Manual Fire Alarm Stations
1. Manual fire alarm stations shall be addressable, single action (without break glass) and appropriately labeled. They will be key reset. All manual fire alarm stations shall be identical.
 2. If manual stations requiring separate addressable elements or monitor modules are used, those elements or modules shall be installed within the device back box or as shown on the approved shop drawings.
- F. Smoke Detectors, Spot-Type
1. Spot-type smoke detectors shall operate on the photoelectric light-scattering principal and have an integral alarm LED.
- G. Smoke Detectors, Duct-Type
1. Duct-type smoke detectors shall operate on the photoelectric light-scattering principal and have an integral alarm LED.
 2. Device shall allow for remote alarm indicating devices (LED).
- H. Smoke Detectors, Air Sampling
1. Air sampling smoke detectors shall be manufactured by VESDA. Air sampling detectors shall consist of a laser-based smoke detector, aspirating fan, controller and filter contained in a control system enclosure.
 2. Detectors shall provide alarms for very early smoke alert, action and fire levels. Detectors shall provide multiple alarm level outputs for connection to the local building fire alarm control panel.
 3. Separate display modules shall be located adjacent to the EST FACP, along with a programmer module and 24 V DC power supplies.
- I. Water Flow Detectors
1. Water flow switches for sprinkler and standpipe systems shall be provided by others.
- J. Pressure Switches
1. Water flow alarm pressure switches shall be provided by others.
- K. Valve Supervisory Switches
1. Valve supervisory switches shall be provided by others. Contractor is responsible for providing conduit, wiring, and integrating supervisory signals into the building fire alarm system.
- L. Audible Devices
1. Audible devices shall be Edwards model number EST GIR-P electronic, non-coded, temporal, or equivalent.
 2. Where speakers are required, they shall be Edwards model number EST 757-1A-S25 or 757-1A-S70, in temporal mode, depending upon application.
- M. Visible Devices
1. Visible signaling devices shall be EST GIR-75, or equivalent.

- N. Combination Audible/Visual Devices
 - 1. Edwards Model EST GIR HV 75, with a temporal arrangement.
 - 2. Where speakers are required, they shall be Edwards model number EST 757-5A-SS25 or 757-5A-SS70, depending upon application.
- O. Fire Alarm System Raceways And Wiring
 - 1. Shall be as specified in the general terms and conditions, Article 760 of NFPA 70, and the following:
 - 2. All single-conductor fire alarm wiring (use limited to power supplies and general wiring-not supervised circuits for detection, monitoring, notification or alarm) shall be solid copper, 18 AWG, or larger, and shall have insulation rated 600 V, (300V for power limited), 90C or higher, and approved for use in wet locations and cable trays.
 - 3. Multiconductor Fire Alarm cable shall be Type FPL, 18 AWG or larger, shall be shielded and solid, and shall be approved for use in wet locations and cable trays.
- P. Heat detectors, spot addressable, shall be EST analog/addressable, with a nominal fixed temperature rating of 212 degrees F. and shall be suitable for ceiling installation.
- Q. Rate Compensated Heat Detectors shall be Fenwal "Detect-a-fire" with a nominal fixed temperature alarm point rating of 212 degrees F and a rate-of-rise alarm point of 15 degrees per minute.
- R. Manual exhaust shutdown switches shall be Edwards model 312/S1RY Control Display Module.
- S. VESDA display and programming modules located adjacent to the EST FACP shall be placed in a lockable subrack with glass face.
- T. Unless required otherwise by code, building fire alarm should sound all annunciation devices in the building.
- U. All copper fire alarm circuits routed via underground conduit shall be provided with a surge (lightning) protection device prior to connection of the circuit to the FACP.

PART 3 - EXECUTION

3.1 DESIGN AND INSTALLATION

- A. Design and installation of the Fire Alarm System shall be in accordance with NFPA 72 and this section.
- B. Where the light output of two or more visible signaling devices is visible in an area, they will be synchronized as required by ADA.
- C. Visual signals shall be mounted at a minimum height of 80 inches above the highest level of the finish floor and a minimum of six inches below ceilings.
- D. All fire alarm wiring shall be run in dedicated raceways or conduit; no other wiring shall be allowed in the fire alarm raceways, conduit, enclosures, or junction boxes (except interfaces to devices and circuits controlled by the fire alarm system). The conduit shall be identified and labeled as containing fire alarm circuits..
- E. All fire alarm wiring shall be installed in metallic raceways or conduit, except short sections of liquid-tight flexible metal conduit shall be allowed at points requiring flexibility or vibration isolation, such as connections to sprinkler flow switches.

- F. Conductors supplying AC power to the fire alarm system shall not be installed in the same raceways, enclosures, or junction boxes as fire alarm signal circuits.
- G. Where the fire alarm system interfaces with other systems for the purpose of fire control, such as fan motor control circuits, or elevator controls, a means shall be provided to test the fire alarm system without affecting the other systems. The method used will be reviewed and approved by the Construction Manager.
- H. Field wiring shall not terminate directly to fire alarm panel components.
- I. Manual fire alarm stations shall be flush- or semi-flush- mounted in finished areas or surface mounted in unfinished areas, using appropriate back boxes and mounting hardware, on permanent walls or columns, 42"-48" from the finish floor to the pull down lever of the manual fire alarm station. Surface mounted back boxes shall be smooth finished, red in color, and shall have no unused knockouts on the back box.
- J. Duct detectors concealed above ceilings or mounted greater than 10'-0" above finished floor shall be equipped with a remote alarm indicating device to indicate that the device is in alarm. The remote indicating device shall be located a maximum of 6'-0" above finished floor.
- K. The fire alarm design and installation will satisfy the requirements of ANSI A 17.1, as outlined in NFPA 101, and will provide necessary inputs to the elevator control system to initiate actions required by that standard. This will include the provision of detection devices at various locations in the buildings and interfacing with elevator control systems.
- L. Air sampling smoke detectors shall be provided with a reliable 24 V power supply which is fed from 120 V power from the building power supplies, and an air sampling pipe network to transport air from the monitored area to the air sampling detector.
- M. Air sampling smoke detector units must be installed in the locations outside the cleanroom that are accessible for testing and maintenance from the floor or a platform without using scaffolding or ladders.
- N. Air sampling pipes shall be CPVC that is approved for residential sprinkler piping.
- O. Air sampling piping and tubing must be designed to maintain its integrity under the expected positive and/or negative pressure created during periodic flushing of the air sampling network.
- P. A user-friendly disconnect must be provided between the air sampling smoke detection unit and the air sampling network to allow for easy disconnection during flushing of the air sampling network.
- Q. The sampling points (holes drilled in the sampling pipes) for the air sampling smoke detection system must be designed to the maximum allowable diameter.
- R. Smoke injection test points for the air sampling smoke detection system must be located such that they are easily accessed from the floor without using scaffolding or ladders and facilitate easy smoke injection.
- S. Air sampling detectors shall be monitored by VESDA display and programming modules located adjacent to the EST FACP for the building. The display and programming modules shall be provided 120 V power from the building power supplies and include a 24 V power supply.

3.2 INSULATION TESTING

- A. All fire alarm system conductors shall be tested for integrity of insulation, prior to connection of any equipment, using a megger operating at 500 VDC. This testing shall be coordinated with the installation schedule to prevent over-voltage damage to system components.
- B. All test values shall be recorded in ohms. All circuits measuring less than 10 M ohms to ground, or between conductors installed in the same conduit, shall be replaced.
- C. Upon completion of insulation testing, the Contractor shall provide written certification documenting successful completion of all required insulation testing in accordance with these Specifications.

3.3 CONTRACTOR'S 100% TEST AND CERTIFICATION

- A. All alarm initiating devices, notification appliances, auxiliary function relays, solenoids, connections to local fire alarm control panels and associated circuits shall be functionally tested in accordance with the approved test plan to verify proper operation (including synchronization) and supervision.
- B. Correct annunciation of all alarm, supervisory and trouble conditions, including any user programmable text messages, shall be verified.
- C. Correct operation of all releasing functions shall be verified.
- D. The Contractor's 100% test shall be conducted with the final system program installed in non-volatile memory. In the event that errors are identified in the system program, the program shall be corrected and all required testing repeated with the new software iteration. The intent of this paragraph is that all required system tests, except insulation testing, be conducted with the final system program installed.
- E. Upon completion of Testing, the Contractor shall provide written certification to the Construction Manager's Representative documenting successful completion of all required tests in accordance with these Specifications.

3.4 FIRE ALARM SYSTEM ACCEPTANCE TEST

- A. It is preferred that the Fire Alarm and Fire Suppression System Acceptance Tests be conducted concurrently. Where this cannot be done, the Construction Manager shall be notified in writing. The Construction Manager shall coordinate with the Contractor to make provisions for partial testing of the systems "as is" and final testing of the systems when construction is complete.
- B. All testing shall be conducted in accordance with NFPA 72, and other appropriate standards. This shall include the provision of the "record of completion."
- C. Upon completion of the Fire Alarm Installation, an Acceptance Test of the fire alarm system shall be performed in the presence of the Construction Manager and/or his designated Representative(s).
 - 1. In preparation for the Acceptance Test, the Contractor shall submit Record Drawings as required elsewhere in these Specifications.
 - 2. The Contractor's Record Drawings will be reviewed for conformance to the applicable Specification requirements. Upon approval of the Record Drawings, one copy will be provided to reflect the Acceptance Test plan.

3. The Contractor shall develop the Acceptance Test Plan in accordance with the appropriate Codes and Standards. The Test Plan shall be submitted to the Construction Manager for approval.
- D. Acceptance Testing will be conducted by the contractor and witnessed by the Construction Manager's Representative, in accordance with the Acceptance Test Plan. The Acceptance Test Plan shall include at a minimum:
1. Functional testing of 100% of the initiating devices.
 2. Functional testing of 100% of the evacuation signaling devices. This testing shall include audibility testing with a dBA meter.
 3. Supervisory testing of 100% of the initiating device circuits.
 4. Supervisory testing of 100% of the evacuation signaling circuits.
 5. Supervisory testing of all power supplies/standby batteries.
 6. Functional testing of all manual functions.
 7. Two consecutive full load tests (all fire alarm initiating devices in alarm and all evacuation signals, annunciators and auxiliary functions activated simultaneously), one under standby battery power and one under normal power, 15 minutes duration each, minimum.
 8. Verification of proper annunciation of all signals, both local and remote, as the system is designed.
 9. Verification of proper system operation under a variety of fault conditions, including power failures, opens, ground faults, and short circuits.
 10. Any additional tests deemed necessary by the Construction Manager or his designated representative.
 11. Turnover of hardcopies and electronic copies of system program and Final Record Drawings (as described elsewhere in this specification.)
- E. 100% successful performance during Acceptance Testing is expected, based on the Contractor's Insulation Testing Documentation and 100% Test Certification required elsewhere in these Specifications. In the event of system performance inconsistent with the Contractor's testing certifications, the Construction Manager will make a determination as to whether or not the test results constitute failure of the Acceptance Test. Failure of the Acceptance Test shall invalidate the Contractor's System Certification, in which case re-certification (including 100% Contractor retesting) and a repeat of the Acceptance Test shall be required at no additional cost.
1. Failure of the Acceptance Test may result in the immediate suspension of all payments to the Contractor, until such time as the required Contractor's retesting/re-certification is complete and the failed Acceptance Test is successfully repeated.

3.5 TRAINING

- A. See the requirements of Specification 16735.

3.6 WARRANTY

- A. The Contractor warrants all equipment installed under this contract for a period of three (3) years. Other warranty provisions are contained in the General and Supplementary Conditions.

3.7 BUILDING SPECIFIC REQUIREMENTS

- A. All building specific requirements, if any, are outlined in the Appendices.

APPENDIX A-1
CENTER FOR NANOPHASE MATERIALS AND SCIENCE
BUILDING 8610

SYSTEMS MATRIX

	Center for Nanophase Materials and Science Building Fire Areas		
	Cleanroom Area	4-Story Laboratory Area	Cleanroom Support Area
Type of Service	Protected Premises, Part of ORNL Proprietary System		
System Arrangement	Sprinkler water flow alarms, sprinkler control valve supervisory alarms, manual fire alarm stations and air sampling smoke detectors shall be connected to the Fire Alarm Control Panel. The Fire Alarm Control Panel shall be interconnected to the Site-wide Fire Alarm System. All signals received by the CNMS Fire Alarm Control Panel shall be appropriately forwarded to the Control Room Fire Alarm Panel (Global) located in the CLO and the ORNL FD Fire Alarm Panel (Global) located in Building 2500. The fire alarm panel will also interface with fire protection features and building systems as necessary to control the environment to ensure that occupants may safely egress the structure.		
Smoke Detection, Spot-type Detectors	Not required.	CNMS IT room ceiling, Room B1-6-52. Computer Room, Room 2-6-61. Elevator Machine Room, Room 4-6-2.	Not required.
Smoke Detection, Air Sampling type Detectors	Air sampling pipe network to be located at roof truss level of cleanroom.	Not required.	Not Required
Smoke Detection, Duct type	Required in air handling units per NFPA 90A.	Required in air handling units per NFPA 90A	Required in air handling units per NFPA 90A
Fire Door Hold-Open Devices	Not required.	Required—Hold open device and power by others, smoke detectors and control by FA Contractor-See Door & Hardware Schedule	Not required.
Sprinkler Water Flow Alarms	Required Device by others	Required Device by others	Required Device by others
Sprinkler Control Valves Supervisory Signal	Required; Switch by others. Floor isolation and annunciation.	Required -Switch by others. Floor by Floor isolation and annunciation. Note tamper alarm required for CNMS IT room.	Included in cleanroom area.
Manual Fire Alarm Stations	Required, per NFPA 101	Required, per NFPA 101	Required, per NFPA 101
Protected Smoke exhaust Switch (Manual)	Two switches required for Cleanroom, switches integral to building FACP. Outputs are NC set of contacts. Control of fans by HVAC Contractor through DDC.	Not required.	Not Required

	Center for Nanophase Materials and Science Building Fire Areas		
	Cleanroom Area	4-Story Laboratory Area	Cleanroom Support Area
Audible Notification Devices	Speakers required Throughout	Speakers required Throughout	Speakers required Throughout
Visual Signal Appliances	Required Throughout	Required Throughout	Required Throughout
Location of Fire Alarm Control Panel	Room B1-7-39 (Fire Riser Room)		
System Operation	Refer to the Input/Output matrix in Appendix A-2.		
System Reliability	Backed-up by battery (minimum 24 hours) and emergency generator All wiring shall be in raceways and supervised.		
System Stability	Components shall be designed for at least a 15-year service life. In addition, all equipment shall be currently available and shall have been used successfully in at least one comparable industrial facility.		
System Expansion	The system shall be designed to have an installed expansion capability, utilizing existing initiating device and notification device circuits, for at least 20% more devices on each initiating device and notification device circuit to have sufficient capacity for future expansion. FACP shall have either a minimum of two spare local rail spaces or the capability of adding an additional chassis to the control panel.		

APPENDIX A-2
CENTER FOR NANOPHASE MATERIALS SCIENCE
BUILDING 8610
INPUT/OUTPUT MATRIX

Fire Alarm Equipment	Transmit Supervisory Signal to Local Panel (FCC) and Site-wide Fire Alarm System	Sound Local Alarms and Activate Door Closers	Transmit Alarm to Local (FCC) and Site-Wide Fire Alarm System	Shut Down HVAC System in Zone	Activate HVAC System Smoke Control Mode.
Sprinkler Water Flow Alarms		X	X		
Sprinkler Control Valves	X				
Smoke Detectors, Duct type		X	X	X Duct detectors in Cleanroom HVAC systems shall alarm only (no automatic shutdown).	
Manual Fire Alarm Stations		X	X		
Protected Smoke Exhaust Switches (Manual)	X				X
Smoke Detectors, Spot Type		X	X		
Air Sampling Smoke Detectors					
Stage 1&2 – Alert	X				
Stage 3 – Action		X	X		
Stage 4 – Fire		X	X		